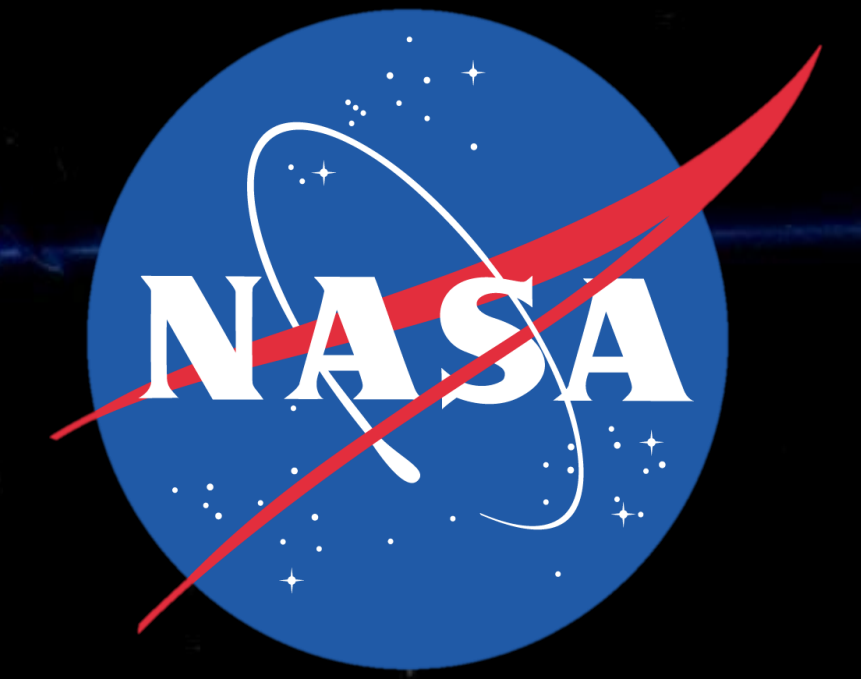




Solar Array and Auroral Charging Studies of DMSP Spacecraft

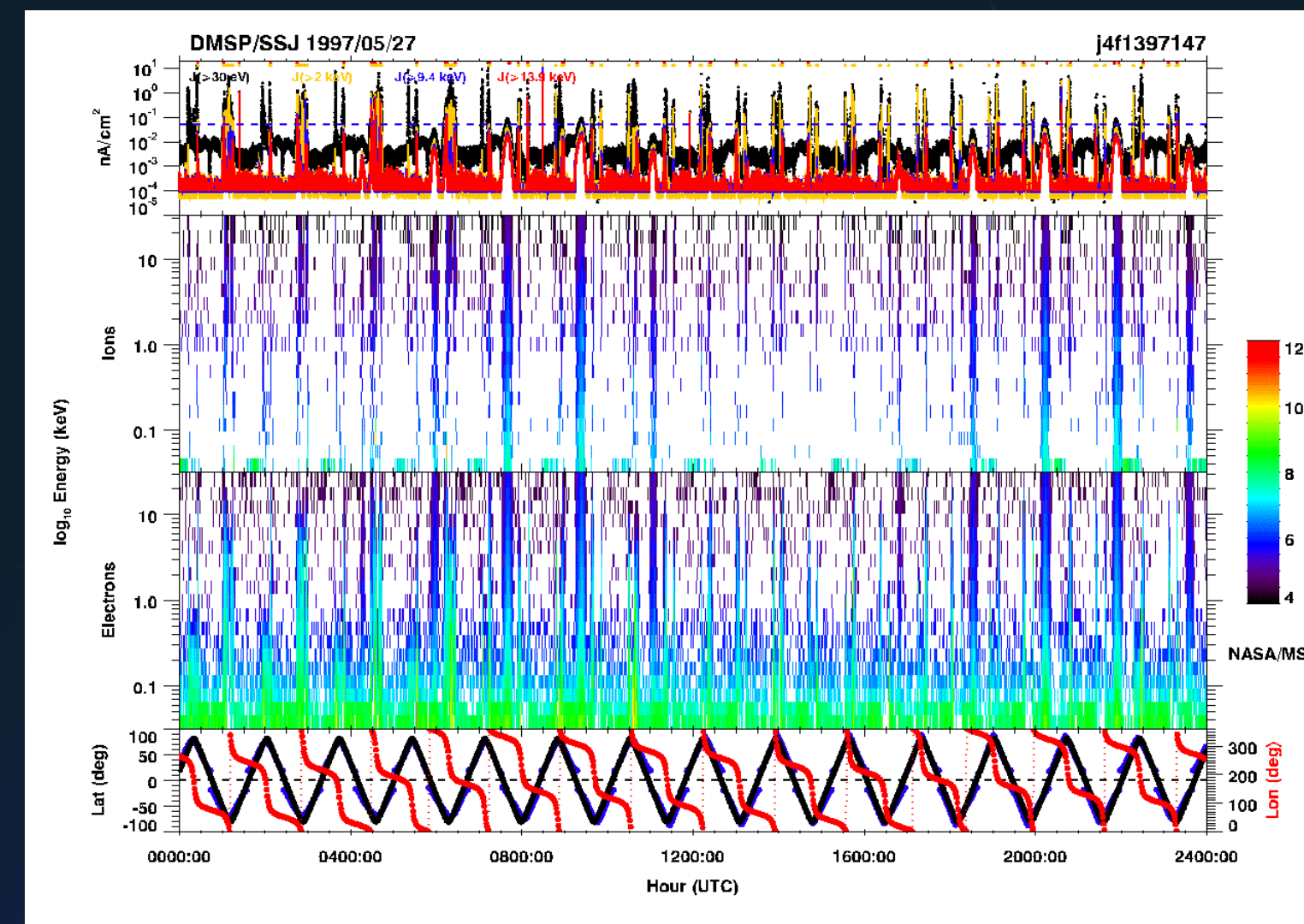
Kelwin Matías, Physics, University of Puerto Rico at Mayagüez
Mentor: Joseph I. Minow, MSFC, Natural Environments, EV44



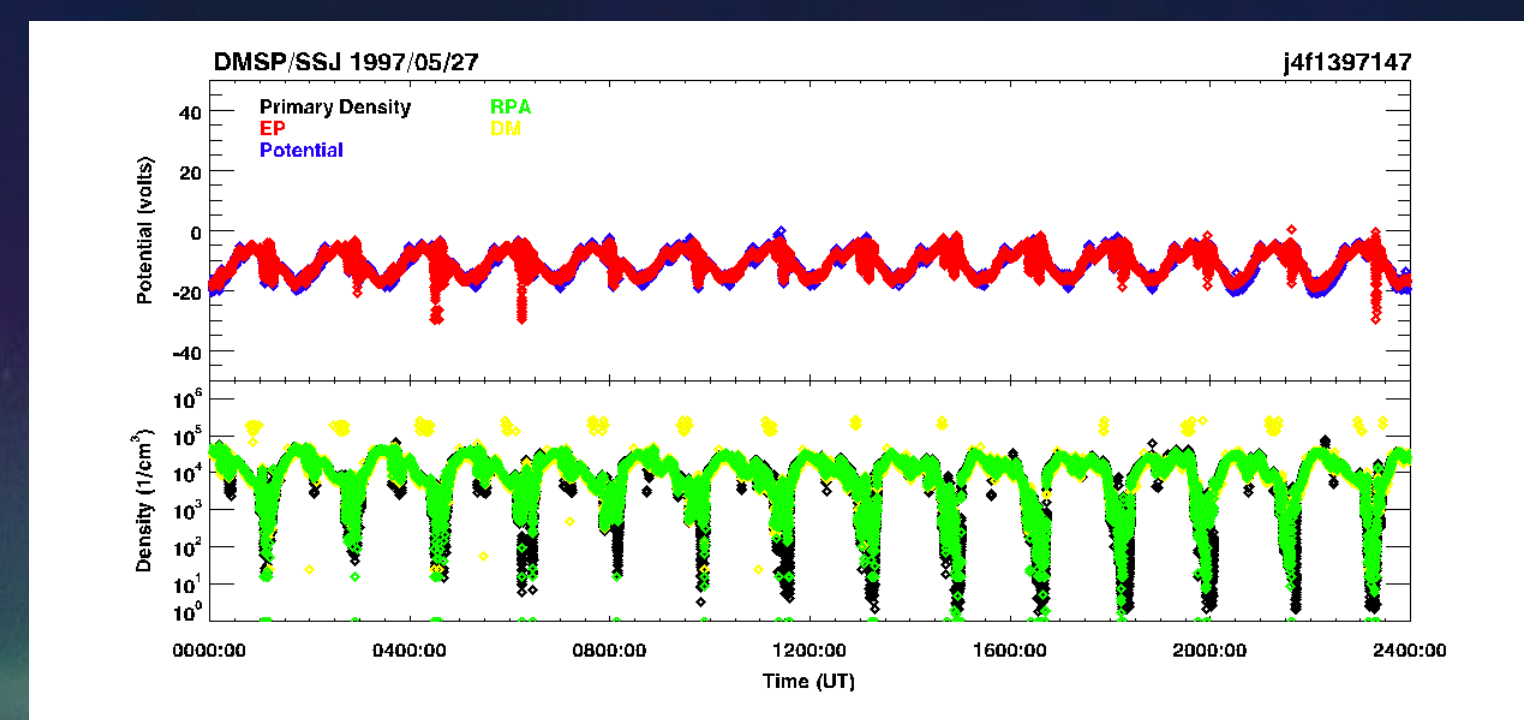
Abstract

The SSJ electrostatic analyzers and the SSIES plasma instruments on the DMSP spacecraft in low Earth polar orbit can be used to conduct case studies of auroral and solar array charging. We will use a program written in the Interactive Data Language (IDL) to evaluate questionable charging events in the SSJ and SSIES data. In addition, we will assemble a number of case studies of solar array charging showing the signatures from the SSJ data and compare to the SSIES charging signatures. In addition we will use Satellite Tool Kit (STK) to propagate orbits, obtain solar intensity, and use to verify onset of charging with sunrise.

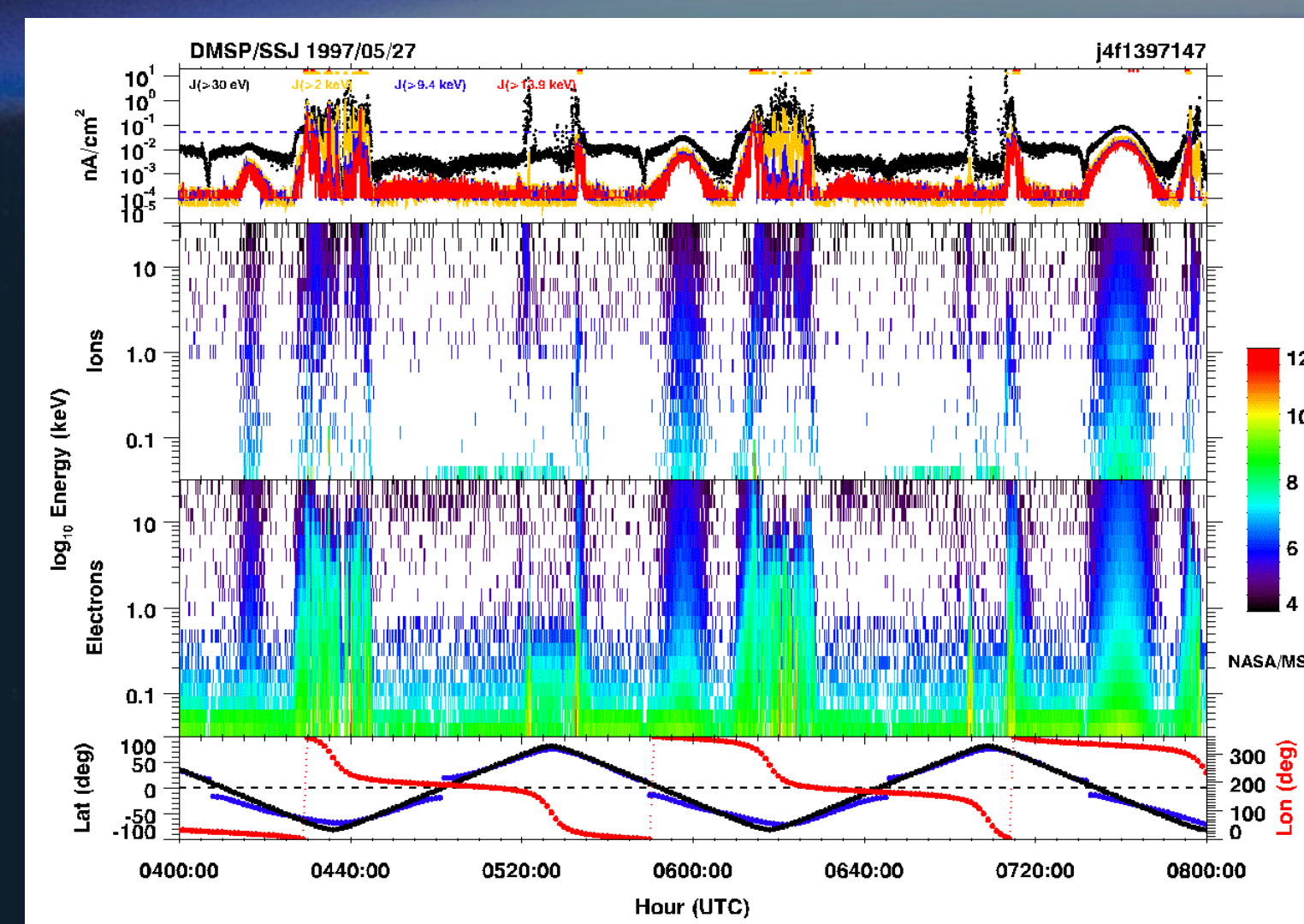
DMSP SSJ/SSIES Data



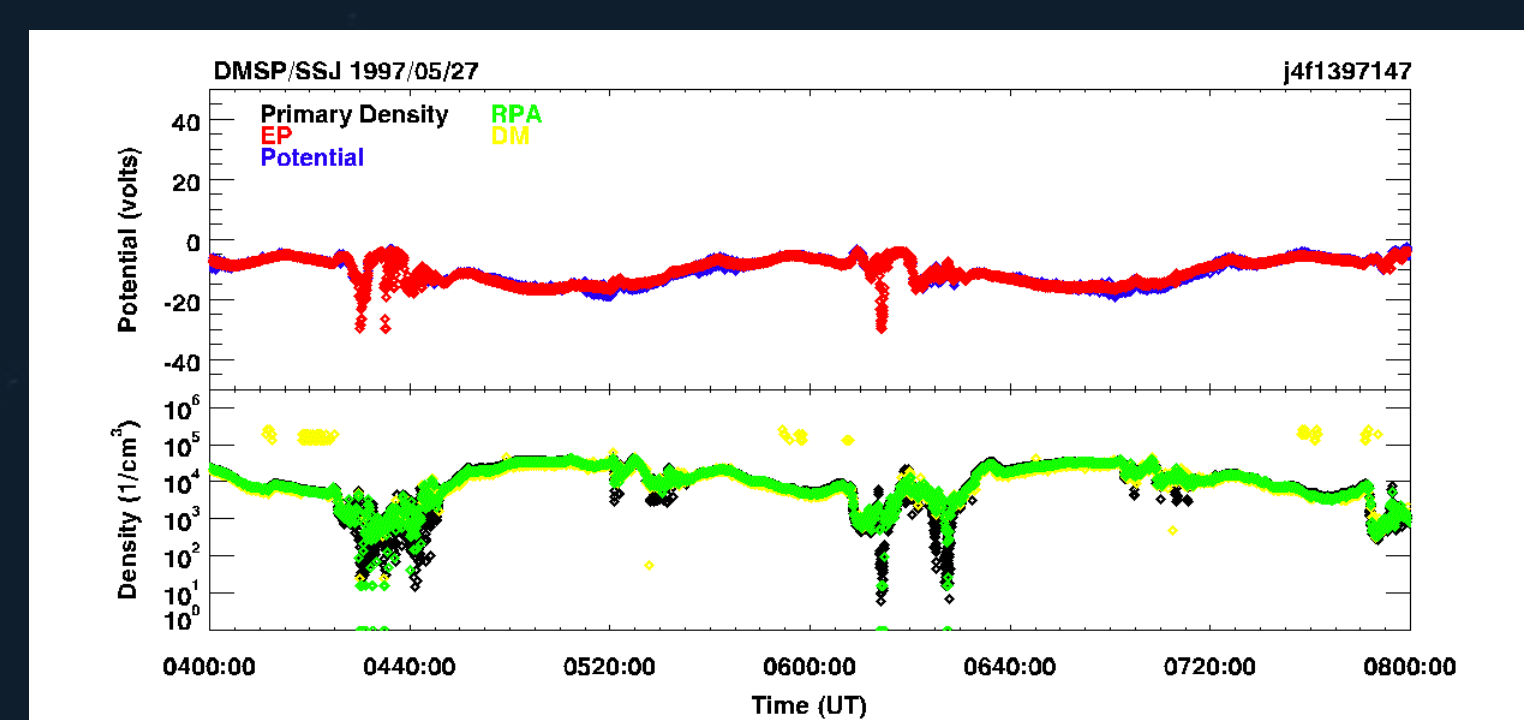
SSJ 24 hrs. Data Plot



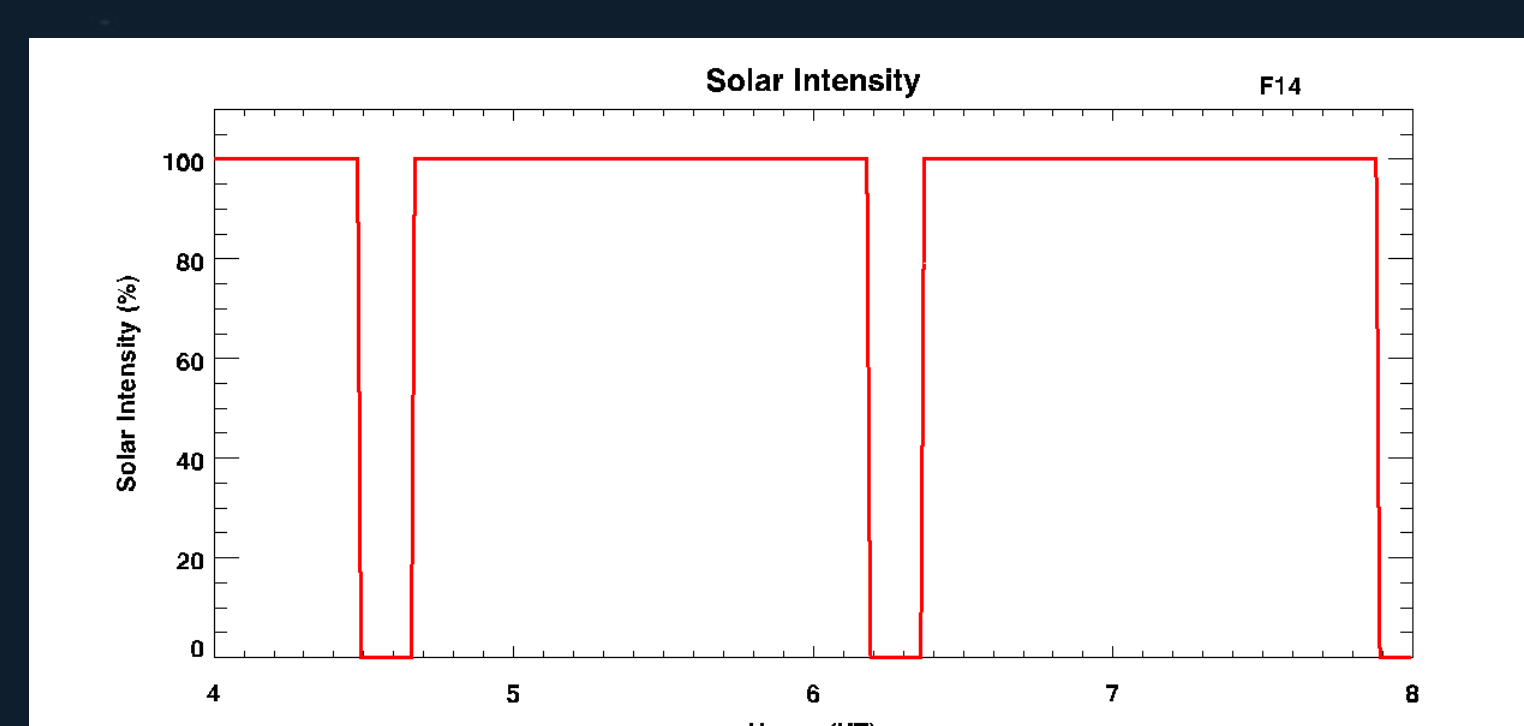
SSIES 24 hrs. Data Plot



SSJ Data Plot

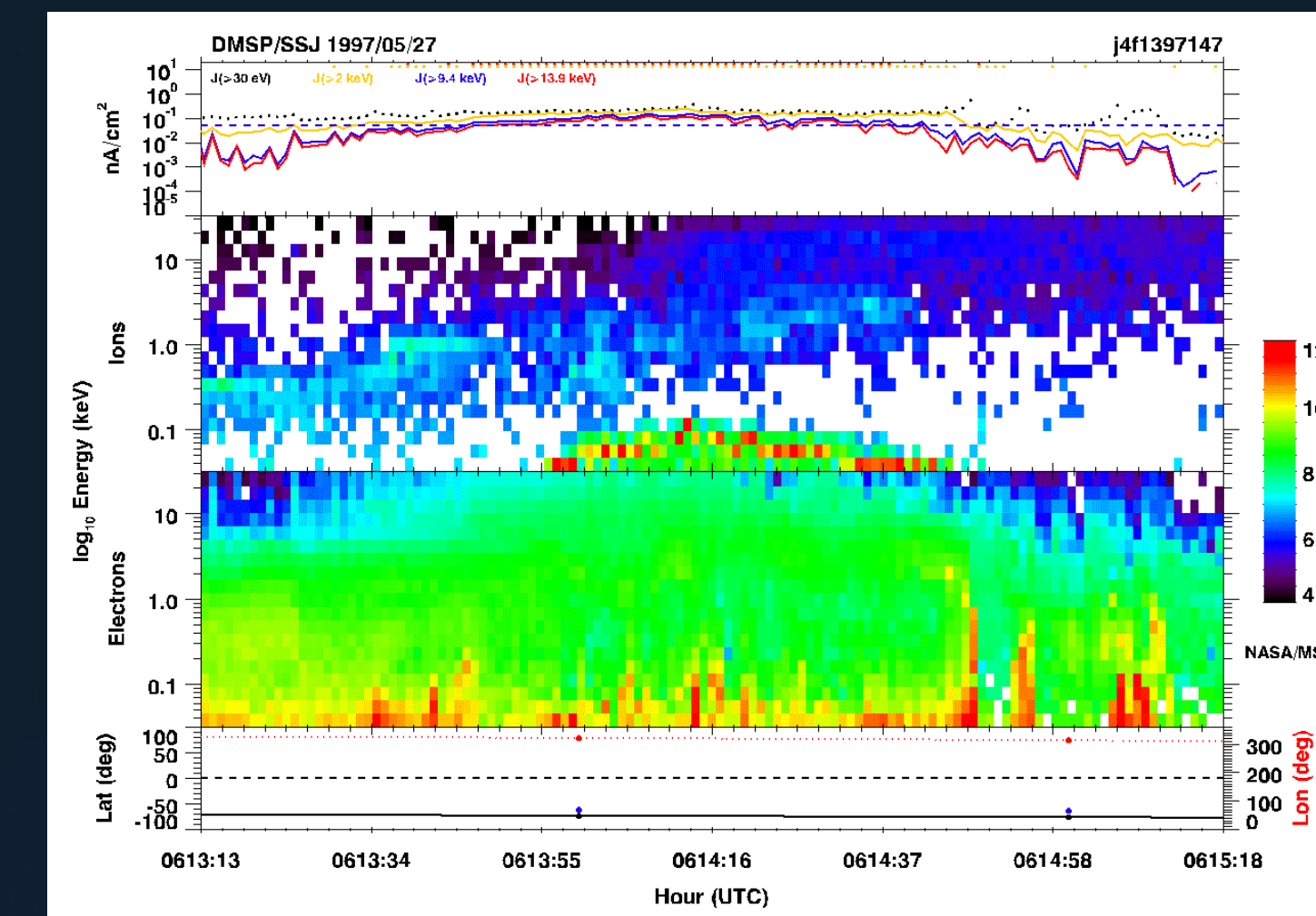


SSIES Data Plot

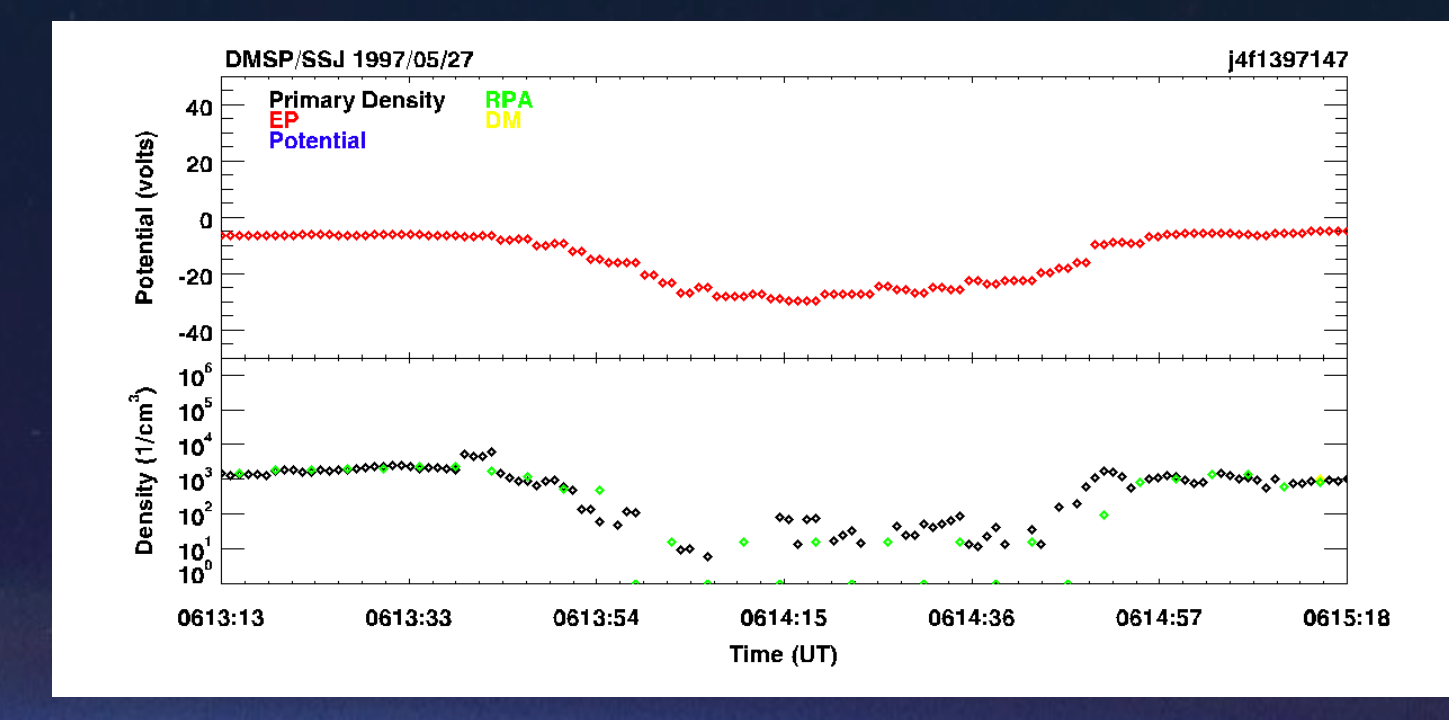


Solar Intensity Plot

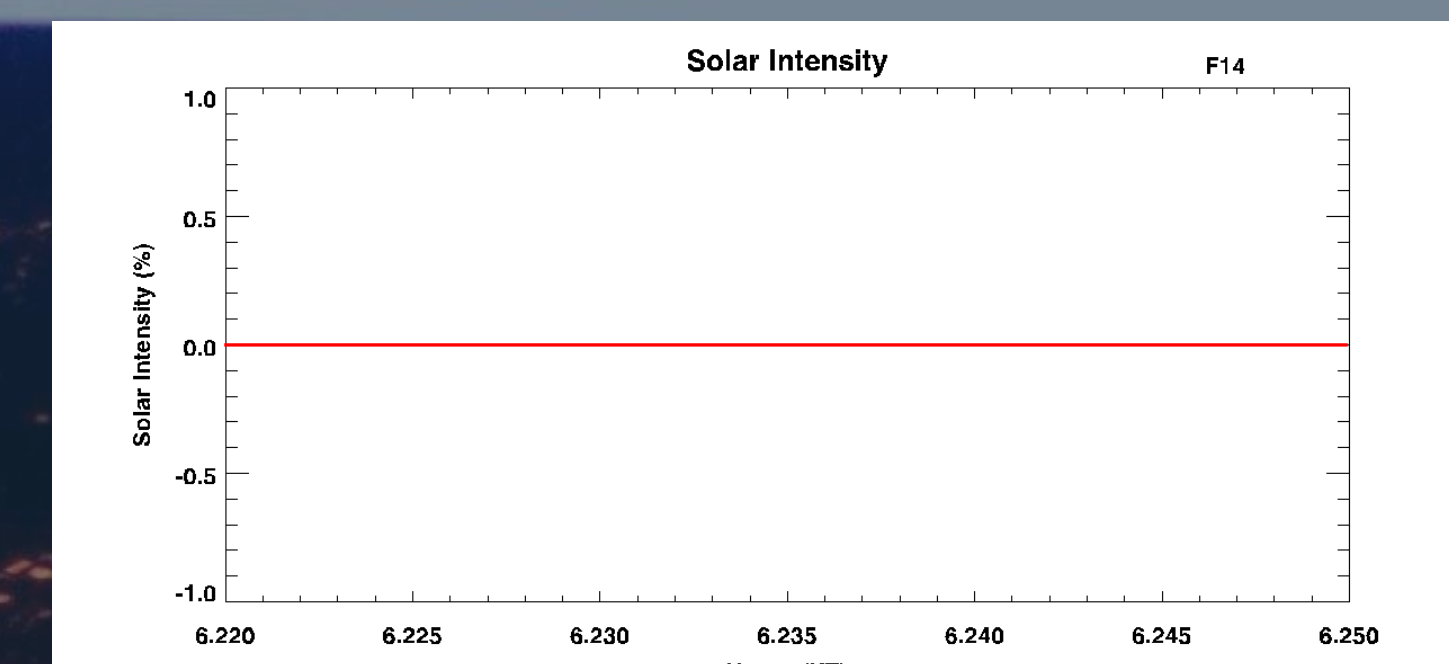
Event 1: DMSP F13



SSJ Data Plot

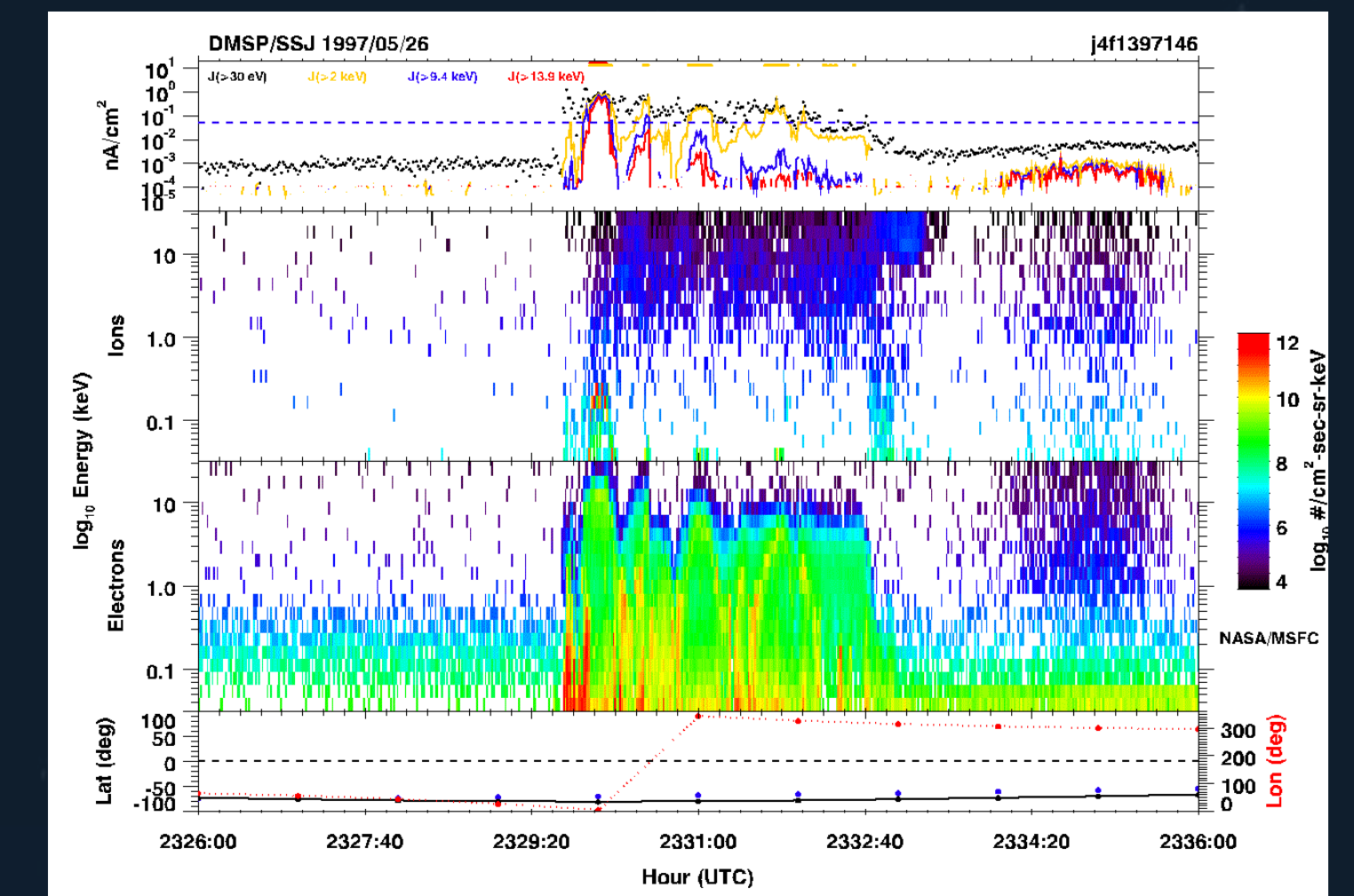


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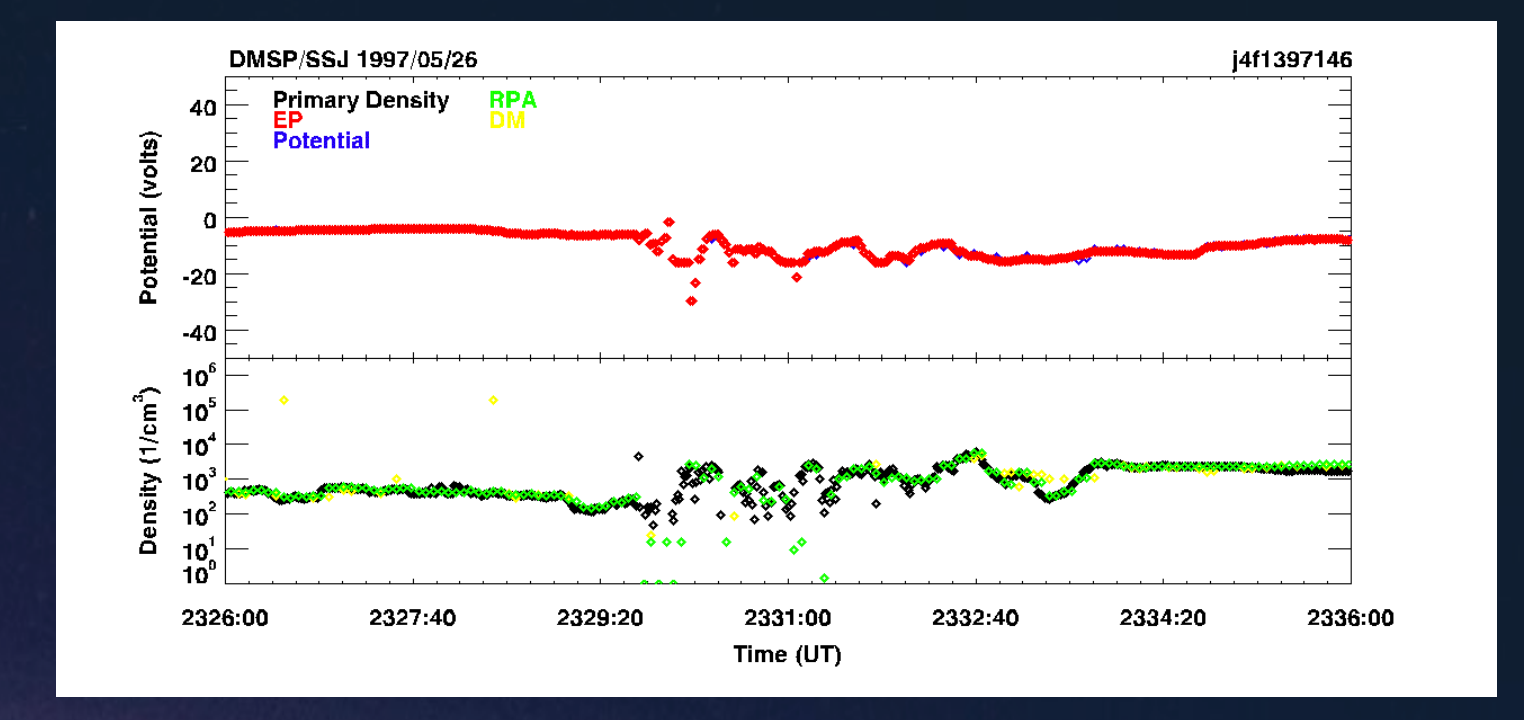


Solar Intensity Plot

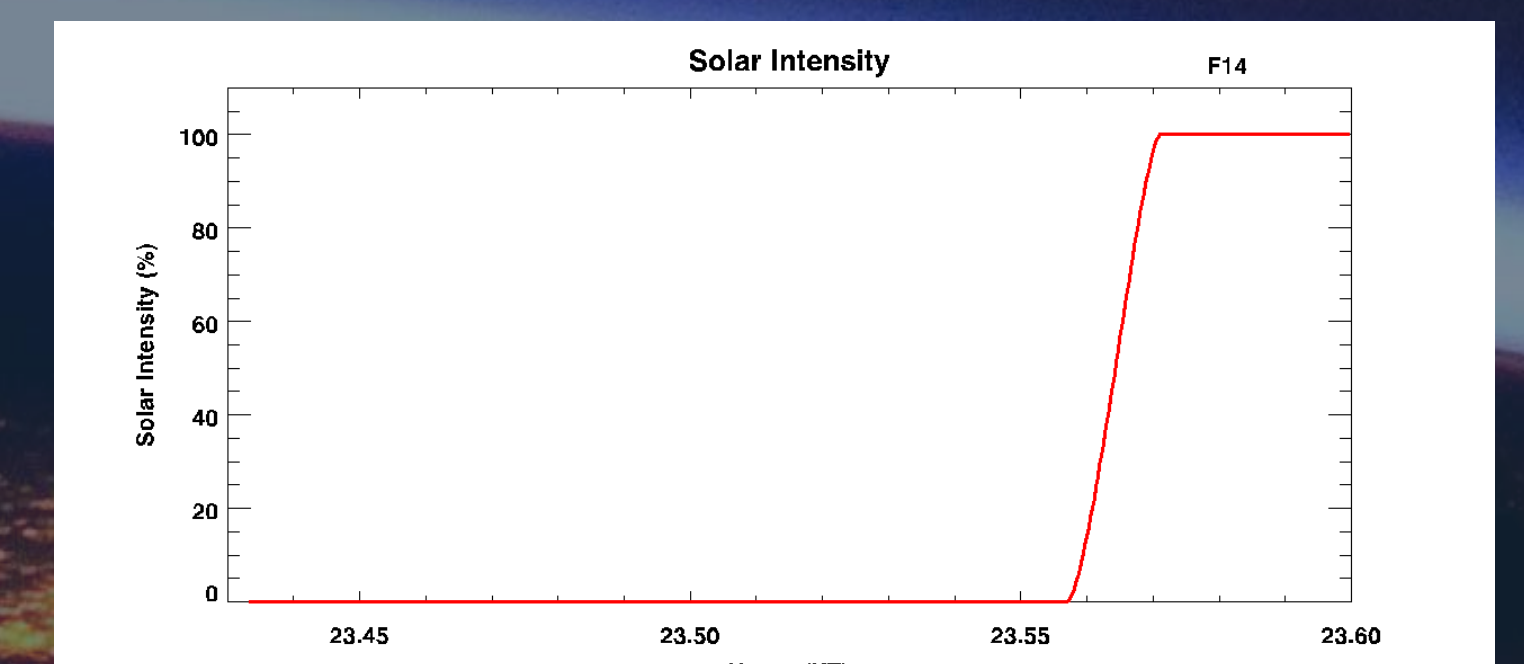
Event 2: DMSP F13



SSJ Data Plot



SSIES Data Plot



Solar Intensity Plot

Conditions Required for Auroral Charging

- ❖ Satellite is in eclipse
- ❖ An intense, energetic electron (>14 keV population) precipitation event is required (flux > 10⁸ electrons cm⁻²s⁻¹sr⁻¹)
- ❖ Locally depleted (< 10⁴ cm⁻³) ambient plasma density

Surface Charging Physics

Surface charging is the result of a current balance on the surface of a spacecraft. Charging is described by the time dependent current balance relation

$$\frac{dQ}{dt} = \frac{d\sigma}{dt} A = C \frac{dV}{dt} = \sum_k I_k \approx 0 \text{ (at equilibrium)}$$

where Q is the total charge and σ the surface charge accumulating on the surface area A , C is the capacitance of the area A , and V the voltage of the surface. The currents of importance to surface charging are: Incident ions, incident electrons, backscattered electrons, conduction currents, secondary electrons, photoelectrons, and active currents (beams, thrusters).

Auroral charging is readily identified from the abrupt change in potential that appears in the SSIES plot. The abrupt change in potential is the result of spacecraft charging.

Event Criteria

- ❖ At least 3 seconds
- ❖ At least -30 V peak
- ❖ Distinguishable ion line, no underlying structure

Discussion and Summary

The data collected from the SSIES instrument can be used to find charging events more effectively. In the SSIES data plots shown here one can easily detect possible charging events just by looking for abrupt changes in the potential plot. This could help in the creation of an automated program that detects possible charging events, making the process of identifying charging events more efficient.

The solar intensity plots were obtained by propagating the satellite's orbit in STK. Using these plots we can confirm that when the charging events occur the satellites are in eclipse. We can also confirm that there is a change in ion density when the satellite goes into darkness.

Acknowledgements

- ❖ Joseph I. Minow, MSFC, EV44
- ❖ NASA Undergraduate Student Research Program
- ❖ NASA Puerto Rico Space Grant Consortium
- ❖ Background Image Credit: NASA